An Indicator of Inclusion with Applications in Computer Vision

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ABSTRACT: In this paper we present an algorithmic process of necessary operations for the automatic movement of a predefined object from a video image in the target region of that image, intended to facilitate the implementation of specialized software applications in solving this kind of problems.

1 INTRODUCTION

The Algorithmic problem-solving procedures for automatic traveling objects within the video images was approached by us also in an earlier work, see [4]. The purpose of this paper is to point out a new method of solving these problems. As mentioned in the earlier work, the process which we'll indicate will be based on the definition of an indicator of Extenics type specialized to signal if a particular set (pixels, in our modeled case) is included in a target set on the monitor screen.

Now, we also mention that both indicators defined in [4] as well as the indicator that we will define in this paper differ fundamentally from the indicators currently used in Extenics theory because they make the leap from the reporting of the position of a single point in relation to one or two given sets to the reporting relationship between two sets -which is much more complex, thus establishing a process that is envisioned to factor in the progress of this theory. The Extenics theory, to which we have referred earlier, have been proposed by Professor Cai Wen in [5].

Because of the importance of this theory in the theoretical and practical field, it was continuously extended, at the beginning by its founder himself, see [6, 7], and then by other researchers from various fields of activity, see [1, 2, 3].

2 AN INDICATOR ABLE TO REPORT IF A SPECIFIC SET IS INCLUDED IN A GIVEN TARGET SET

This paragraph is dedicated to present new results in order to complete and improve the existent Extenics theory. The framework in which we will address these results is that of a measurable metric space expressed through the quadruple $\left(X, d, B_X, \mu\right)$, where X is the set of points which make up the considered space, d is the metric of the space, B_X is the family of the Borelian elements of X [(1)], and μ is the measure on B_X.

For any two non-empty sets A and B from X we introduce the indicator

$$\Delta\left(A, B\right) = \sup\left\{\delta\left(a, B\right) \mid a \in A\right\}, \tag{1}$$

where we noted $\delta(a, B)$ the usual distance from the point $a \in A$ to the set B, that is $\delta(a, B) = \inf\{d(a, b) \mid b \in B\}$.

Observations: 1) The relation $\Delta(A, B) = \Delta(B, A)$ is not always true, in other words, the value of the indicator $\Delta(A, B)$ depends, in general, of the order in which the sets A and B are considered.

2) The indicator $\Delta(A, B)$ can take also infinite values.

3) In the case of two bounded sets A and B [(2)] the indicator $\Delta(A, B)$ if finite.

This indicator has the following Properties:

1) $\Delta(A, B) = 0 \Rightarrow A \subseteq B$ μ - almost everywhere. Reciprocally, $A \subseteq B \Rightarrow \Delta(A, B) = 0$.

2) $\Delta(A, B) = \Delta(B, A) = 0 \Rightarrow A = B$ μ - almost everywhere. Reciprocally, $A = B \Rightarrow \Delta(A, B) = \Delta(B, A) = 0$.

3) $H(A, B) = \max\{\Delta(A, B), \Delta(B, A)\}$ represents the Hausdorff distance between the sets A and B.

Remark: Due to Property 1 from above, the indicator Δ, defined by the Relation (1), is named indicator of inclusion.

[(1)] We define B_X as the smallest collection of subsets of X with the following properties: 1) B_X contains every open set and every closed set of the metric space (X, d); 2) B_X contains the union of every finite or countable collection of sets from B_X; 3) B_X contains the intersection of every finite or countable collection of sets from B_X.

[(2)] A set Y from X is called bounded if its diameter $D(Y) = \sup\{d(y_1, y_2) \mid y_1, y_2 \in Y\}$ is bounded.

3 APPLICATIONS

The pointer Δ specified by us in this paper can be used to solve the problems posed by the development of software applications for an automated movement of a specific object O from a given video image "ImV" in a target region "R" of that image. In order to achieve this goal, we use an algorithm similar to the one that was defined in [4]. In very general terms, the new algorithm has the following content: through a set of isometries I_i, $i \in I$ of the plane, we move the object O in different regions and positions of the image "ImV" by calculating every time the value of each indicator $\Delta(\mathsf{I}_i(\mathsf{O}), \mathsf{R})$. The determination of the indices $i_0 \in I$ for which $\Delta(\mathsf{I}_{i_0}(\mathsf{O}), \mathsf{R}) = 0$ indicates the solving of the problem.

Observation: Just as the algorithm presented in [4], this algorithm can be easily adapted to solving some similar problems in the space of three dimensions, becoming even more useful in projecting the artificial intelligence forms.

4 REFERENCES

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